Columbia Accident Investigation

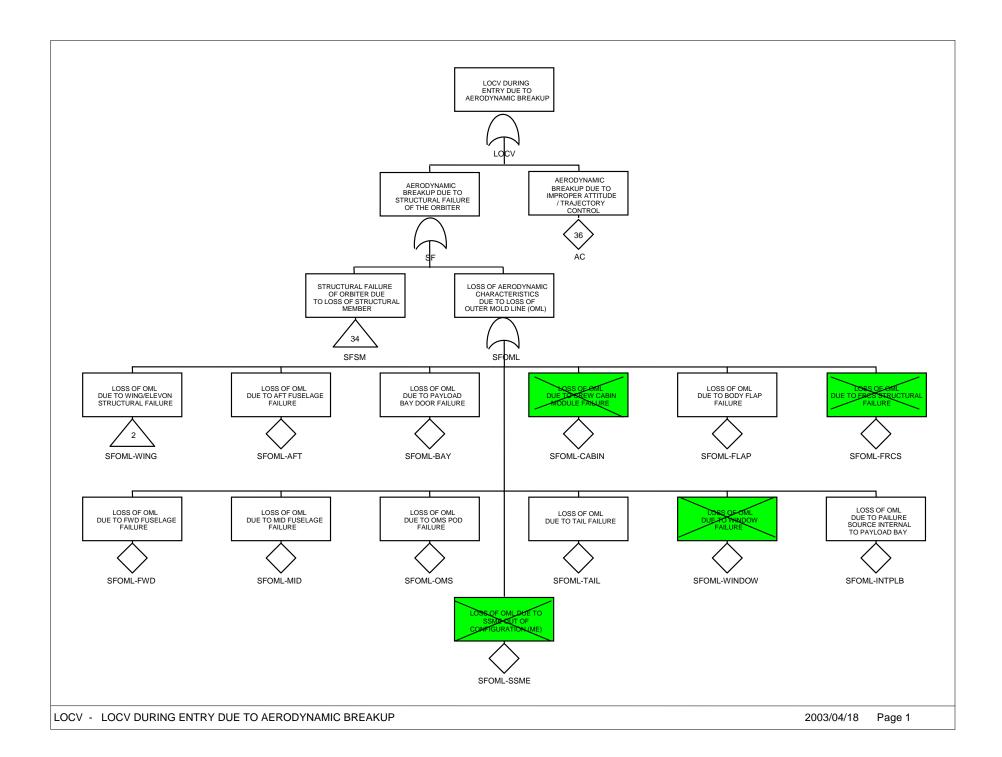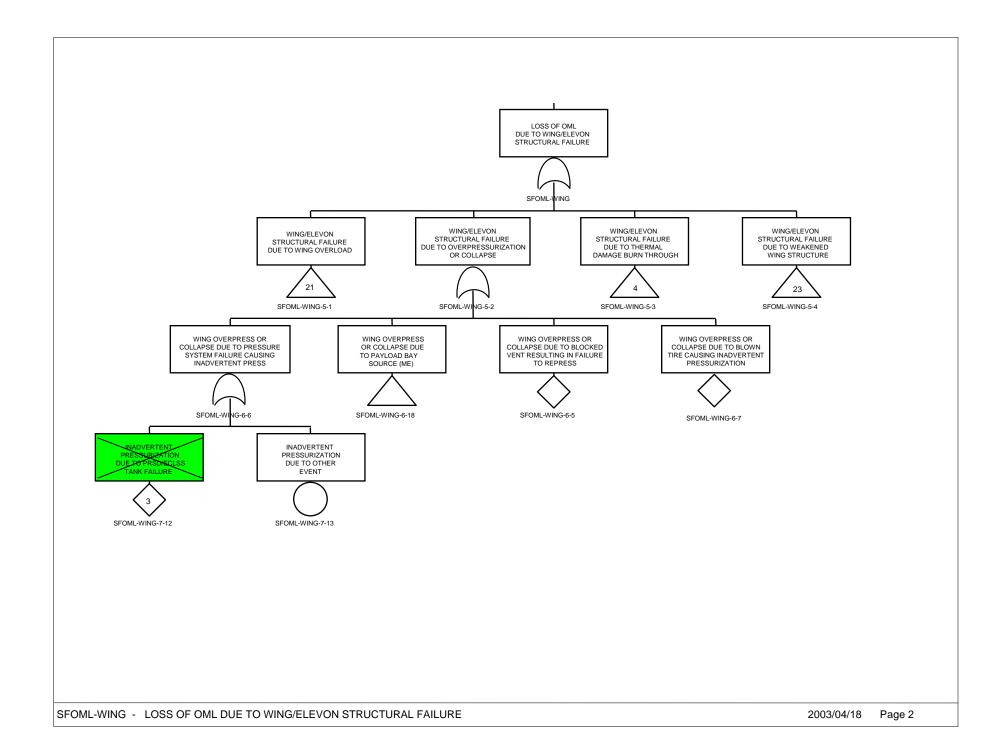## FAULT TREE
VERSION 5.0
April 18, 2003

Shaded Events: Closed by FTTRT

Shaded Events/With X: Closed by NAIT/OVEWG

LOSS OF OML
DUE TO WING/ELEVON
STRUCTURAL FAILURE

SFOML-WING

WING/ELEVON
STRUCTURAL FAILURE
DUE TO WING OVERLOAD

21

SFOML-WING-5-1

WING/ELEVON
STRUCTURAL FAILURE
DUE TO OVERPRESSURIZATION
OR COLLAPSE

SFOML-WING-5-2

WING/ELEVON
STRUCTURAL FAILURE
DUE TO THERMAL
DAMAGE BURN THROUGH

4

SFOML-WING-5-3

WING/ELEVON
STRUCTURAL FAILURE
DUE TO WEAKENED
WING STRUCTURE

23

SFOML-WING-5-4

WING OVERPRESS OR
COLLAPSE DUE TO PRESSURE
SYSTEM FAILURE CAUSING
INADVERTENT PRESS

SFOML-WING-6-6

WING OVERPRESS
OR COLLAPSE DUE
TO PAYLOAD BAY
SOURCE (ME)

SFOML-WING-6-18

WING OVERPRESS OR
COLLAPSE DUE TO BLOCKED
VENT RESULTING IN FAILURE
TO REPRESS

SFOML-WING-6-5

WING OVERPRESS OR
COLLAPSE DUE TO BLOWN
TIRE CAUSING INADVERTENT
PRESSURIZATION

SFOML-WING-6-7

INADVERTENT
PRESSURIZATION
DUE TO PRSD/ECLSS
TANK FAILURE

3

SFOML-WING-7-12

INADVERTENT
PRESSURIZATION
DUE TO OTHER
EVENT

SFOML-WING-7-13

INADVERTENT PRESSURIZATION DUE TO PRSD/ECLSS TANK FAILURE

SFOML-WING-7-12

PRSD RUPTURE OR FIRE/EXPLOSION

ECLSS TANK FAILURE

SFOML-WING-8-46

SFOML-WING-8-47

WING/ELEVON STRUCTURAL FAILURE DUE TO THERMAL DAMAGE BURN THROUGH

SFOML-WING-5-3

OVERHEAT/BURN THROUGH DUE TO TPS MALFUNCTION

SFOML-WING-6-10

OVERHEAT/ THERMAL DAMAGE/BURN THROUGH DUE TO INADVERTENT OPENING IN WING ALLOWING PLASMA FLOW

SFOML-WING-6-9

THERMAL DAMAGE BURN THROUGH DUE TO HIGHER HEATING

6

SFOML-WING-6-8

TPS MALFUNCTION DUE TO REINFORCED CARBON-CARBON (RCC) FAILURE

8

SFOML-WING-7-20

TPS MALFUNCTION DUE TO TILE FAILURE

18

SFOML-WING-7-21

TPS MALFUNCTION DUE TO BLANKET FAILURE

20

SFOML-WING-7-22

TPS MALFUNCTION DUE TO SEAL FAILURE

SFOML-WING-7-23

INADVERTENT DOOR OPEN OR BREACH OF THERMAL SEAL (GEAR REMAINS UP)

SFOML-WING-7-18

INADVERTENT OPENING IN WING ALLOWING PLASMA FLOW DUE TO FLIPPER DOOR FAILURE

SFOML-WING-7-19

SEAL FAILURE DUE TO THERMAL BARRIER FAILURE

SFOML-WING-8-22

SEAL FAILURE DUE TO ENVIRONMENTAL SEAL FAILURE

7

SFOML-WING-8-24

SEAL FAILURE DUE TO ELEVON COVE SEAL FAILURE

SFOML-WING-8-23

THERMAL BARRIER FAILURE DUE TO LANDING GEAR THERMAL BARRIER FAILURE

SFOML-WING-9-32

THERMAL BARRIER FAILURE DUE TO ET UMBILICAL DOOR THERMAL BARRIER FAILURE

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SFOML-WING-9-33

IMPACT

12

SFOML-WING-10-48

SNEAK FLOW

11

SFOML-WING-9-24

LANDING GEAR THERMAL BARRIER FAILURE DUE TO FLIGHT OUTSIDE ENVELOPE (ME)

SFOML-WING-9-46

LANDING GEAR THERMAL BARRIER FAILURE DUE TO INSTALL/CLOSING

SFOML-WING-10-18

LANDING GEAR THERMAL BARRIER FAILURE DUE TO DEGRADATION OF THERMAL BARRIER

SFOML-WING-10-17

THERMAL BARRIER FAILURE DUE TO ET UMBILICAL DOOR THERMAL BARRIER FAILURE

SFOML-WING-9-33

ET UMBILICAL DOOR T/B FAILURE DUE TO OFF NOMINAL ET SEPARATION (ME)

SFOML-WING-10-52

ET UMBILICAL DOOR T/B FAILURE DUE TO IMPROPER INSTALL / CLOSING

SFOML-WING-10-19

SNEAK FLOW

SFOML-WING-9-24

ET UMBILICAL DOOR T/B FAILURE DUE TO THERMAL BARRIER FAILURE INSIDE LIFETIME

SFOML-WING-10-21

ET UMBILICAL DOOR T/B FAILURE DUE TO FLIGHT OUTSIDE CERTIFIED ENVIRONMENT (ME)

SFOML-WING-10-35

IMPACT

SFOML-WING-10-49

ET UMBILICAL DOOR T/B FAILURE DUE TO DEBRIS DURING CLOSING

SFOML-WING-10-20

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                        ┌─────────────────────┐
                        │   THERMAL DAMAGE    │
                        │  BURN THROUGH DUE   │
                        │  TO HIGHER HEATING  │
                        └─────────────────────┘
                               ◇
                      SFOML-WING-6-8
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| HIGHER HEATING DUE TO OFF NOMINAL TRAJECTORY | HIGHER HEATING DUE TO UNEXPECTED FLOW | HIGHER HEATING DUE TO UNUSUAL ENVIRONMENT | HIGHER HEATING DUE TO HEAVY ENTRY WEIGHT |

SFOML-WING-7-14   SFOML-WING-7-15   SFOML-WING-7-16   SFOML-WING-7-17

| UNEXPECTED FLOW DUE TO EARLY TRANSITION (STEP/GAP) | UNEXPECTED FLOW DUE TO AERO PHENOMENA (ASYMMETRIC TRANSITION SHOCK WAVE) | UNEXPECTED FLOW DUE TO CHEMISTRY OR MATERIALS PROBLEM (CATALYSIS OR CONTAMINATION) | UNEXPECTED FLOW DUE TO ASYMMETRIC BOUNDARY LAYER TRANSITION |

SFOML-WING-8-7   SFOML-WING-8-8   SFOML-WING-8-9   SFOML-WING-8-52

SEAL FAILURE DUE TO
ENVIRONMENTAL
SEAL FAILURE

SFOML-WING-8-24

ENVIRONMENTAL SEAL
FAILURE DUE TO LANDING
GEAR DOOR FAILURE

ENVIRONMENTAL SEAL
FAILURE DUE TO ET
UMBILICAL DOOR FAILURE

SFOML-WING-9-35

SFOML-WING-9-36

TPS MALFUNCTION DUE TO REINFORCED CARBON-CARBON (RCC) FAILURE

SFOML-WING-7-20

RCC FAILURE DUE TO IMPACT CAUSING CRACK/HOLE >=0.25 IN ON BOTTOM 1.0 IN ON TOP

12

SFOML-WING-8-10

RCC FAILURE DUE TO LOSS OF RCC PANEL

9

SFOML-WING-8-14

RCC PANEL IMPROPER INSTALLATION

SFOML-WING-8-51

RCC FAILURE DUE TO IMPROPER RCC REPAIR

SFOML-WING-8-53

RCC FAILURE DUE TO DEGRADED COATING EXPOSES RCC SUBSTRATE

17

SFOML-WING-8-12

RCC FAILURE DUE TO ENVIRONMENT OUTSIDE RCC CERTIFICATION (ME)

SFOML-WING-8-13

RCC FAILURE DUE TO CRACK/HOLE <0.25 IN ON BOTTOM 1.0 IN ON TOP NOT SIGNIFICANT

SFOML-WING-8-11

RCC MANUFACTURING / MATERIAL DEFECT

SFOML-WING-8-54

RCC FAILURE DUE TO
LOSS OF RCC PANEL

SFOML-WING-8-14

LOSS OF RCC PANEL DUE TO
SUPPORTING STRUCTURE
FAILURE

10

SFOML-WING-9-19

LOSS OF RCC PANEL
DUE TO IMPACT

12

SFOML-WING-9-53

LOSS OF RCC PANEL DUE
TO ADJACENT LOSS OF
CARRIER PANEL

SFOML-WING-9-21

LOSS OF RCC PANEL DUE
TO RCC PANEL
FASTENER FAILURE

SFOML-WING-9-20

LOSS OF CARRIER
PANEL DUE TO
FASTENER FAILURE

SFOML-WING-10-10

LOSS OF CARRIER
PANEL DUE TO
FLOW PENETRATING
WING SEAL

SFOML-WING-10-11

IMPACT

12

SFOML-WING-11-34

SNEAK FLOW

11

SFOML-WING-9-24

FASTENER FAILURE
DUE TO IMPROPER
INSTALLATION

SFOML-WING-11-14

LOSS OF RCC PANEL DUE TO
SUPPORTING STRUCTURE
FAILURE

SFOML-WING-9-19

SUPPORTING
STRUCTURAL
FAILURE DUE TO
SNEAK FLOW

SFOML-WING-10-50

LOSS OF RCC
PANEL DUE TO
SEAL FAILURE

SFOML-WING-10-51

SUPPORTING STRUCTURAL
FAILURE DUE TO INTERNAL
INSULATION FAILURE

SFOML-WING-10-8

WING LEADING EDGE
STRUCTURE FAILURE

SFOML-WING-10-9

SNEAK FLOW DUE
TO RCC DAMAGE

SFOML-WING-11-10

SNEAK FLOW

11

SFOML-WING-9-24

LOSS OF RCC PANEL
DUE TO T-SEAL
FAILURE

SFOML-WING-11-66

LOSS OF RCC PANEL
DUE TO ANGLE SEAL
FAILURE

SFOML-WING-11-67

LOSS OF RCC PANEL
DUE TO BUTTERFLY
SEAL FAILURE

SFOML-WING-11-68

RCC DAMAGE DUE
TO IMPACT

12

SFOML-WING-12-9

RCC DAMAGE DUE
TO OTHER EVENT

SFOML-WING-12-10

SNEAK FLOW

SFOML-WING-9-24

SNEAK FLOW DUE
TO TILE DAMAGE

SFOML-WING-11-11

SNEAK FLOW DUE
TO STRUCTURAL
DEFLECTION

SFOML-WING-11-19

SNEAK FLOW DUE
TO SEAL DAMAGE
INDUCED BY OTHER
EVENT

SFOML-WING-12-13

SNEAK FLOW DUE
TO MISSING/DISPLACED
GAP FILLER

SFOML-WING-11-65

TILE DAMAGE
DUE TO IMPACT

12

SFOML-WING-12-11

TILE DAMAGE
DUE TO OTHER
EVENT

SFOML-WING-12-12

RCC FAILUREDUE TO IMPACTCAUSING CRACK/HOLE>= 0.25 IN ON BOTTOM 1.0 IN ON TOP

SFOML-WING-8-10

INFLIGHT IMPACT

PRE-LAUNCH IMPACT
(ME)

13

SFOML-WING-9-10

SFOML-WING-9-11

PRE LAUNCH UNIDENTIFIED IMPACT WHILE ON LAUNCH PAD (ME)

PRE LAUNCH UNIDENTIFIED IMPACT WHILE IN VEHICLE ASSEMBLY BUILDING

PRE LAUNCH UNIDENTIFIED IMPACT WHILE IN ORBITER PROCESSING FACILITY

PRE LAUNCH UNIDENTIFIED IMPACT DURING TRANSPORTATION (SCA, ORBITER TRANSPORTER, CRAWLER)

SFOML-WING-10-5

SFOML-WING-10-6

SFOML-WING-10-7

SFOML-WING-10-33

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                              ┌─────────────┐
                              │  INFLIGHT   │
                              │   IMPACT    │
                              └─────────────┘
                                     │
                                    ╱‾╲
                                   SFOML-WING-9-10

   ┌──────────────┐   ┌──────────────┐   ┌──────────────┐   ┌──────────────┐
   │  ON ORBIT    │   │ INFLIGHT     │   │   ENTRY      │   │ CONTACT WITH │
   │  IMPACT      │   │ IMPACT       │   │   IMPACT     │   │ ELEMENTS OR  │
   │              │   │ ON ASCENT    │   │              │   │ LAUNCH PAD   │
   └──────────────┘   └──────────────┘   └──────────────┘   └──────────────┘
         △                  △                  △                  △
        /14\               /15\               /16\              /    \
       ──────             ──────             ──────            ────────
   SFOML-WING-10-2    SFOML-WING-10-3    SFOML-WING-10-4    SFOML-WING-11-63
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INFLIGHT IMPACT ON ASCENT

SFOML-WING-10-3

SRB DEBRIS IMPACT ON ASCENT (ME)

SFOML-WING-11-8

ET DEBRIS IMPACTON ASCENT (ME)

SFOML-WING-11-5

RSRM DEBRIS IMPACT ON ASCENT (ME)

SFOML-WING-11-7

LIFT OFF (PAD DEBRIS) IMPACT (ME)

SFOML-WING-11-18

ORBITER CAUSED INFLIGHT IMPACT ON ASCENT

SFOML-WING-11-6

SSME DEBRIS IMPACT (ME)

SFOML-WING-11-64

ORBITER HARDWARE

SFOML-WING-12-25

FOD

SFOML-WING-12-24

TPS IMPACTS ORBITER

SFOML-WING-11-60

ORBITER ACCESS PANEL

SFOML-WING-11-61

RCC FAILURE DUE TO
DEGRADED COATING
EXPOSES RCC
SUBSTRATE

SFOML-WING-8-12

DEGRADED COATING EXPOSES RCC SUBSTRATE DUE TO PINHOLES	DEGRADED COATING EXPOSES RCC SUBSTRATE DUE TO CONTAMINATION	DEGRADED COATING EXPOSES RCC SUBSTRATE DUE TO ATOMIC OXYGEN	DEGRADED COATING EXPOSES RCC SUBSTRATE DUE TO AGING
SFOML-WING-9-12	SFOML-WING-9-13	SFOML-WING-9-15	SFOML-WING-9-16

DEGRADED COATING
EXPOSES RCC
SUBSTRATE DUE TO
IMPACT

12

SFOML-WING-9-14

DEGRADED COATING DUE
TO ENVIRONMENTS (ME)

SFOML-WING-9-59

DEGRADED COATING
EXPOSES RCC SUBSTRATE
DUE TO IMPROPER COATING

SFOML-WING-9-17

TPS MALFUNCTION DUE TO TILE FAILURE

SFOML-WING-7-21

TILE FAILURE DUE TO TILE DEBOND — 19 — SFOML-WING-8-15

TILE FAILURE DUE TO LOST CARRIER PANEL — SFOML-WING-8-18

TILE FAILURE DUE TO BROKEN TILE — SFOML-WING-8-16

TILE FAILURE DUE TO FAILED REPAIR — SFOML-WING-8-17

TILE FAILURE DUE TO FLIGHT OUTSIDE CERTIFIED ENVIRONMENT (ME) — SFOML-WING-8-42

IMPACT — 12 — SFOML-WING-9-57

LOST CARRIER PANEL DUE TO FAILED FASTENERS — SFOML-WING-9-27

LOST CARRIER PANEL DUE TO FLOW PENETRATING WING SEAL — SFOML-WING-9-28

IMPACT — 12 — SFOML-WING-9-54

ANALYSIS MISSED OUT-OF-PLANE DEFLECTION FOR TILE — SFOML-WING-9-47

TILE NOT WATER-PROOFED — SFOML-WING-9-25

SNEAK FLOW — 11 — SFOML-WING-9-24

FAILED FASTENERS DUE TO IMPROPER INSTALLATION — SFOML-WING-10-14

TILE FAILURE
DUE TO TILE DEBOND

SFOML-WING-8-15

TILE DEBOND
DUE TO FAULTY
BOND INTEGRITY

SNEAK FLOW

TILE DEBOND
DUE TO IMPROPER
INSTALLATION

SFOML-WING-9-23

11

SFOML-WING-9-24

SFOML-WING-9-22

FAULTY BOND
INTEGRITY DUE
TO OTHER FLUIDS

FAULTY BOND
INTEGRITY DUE
TO AGE

SFOML-WING-10-13

SFOML-WING-10-12

LEAKS PRIOR
TO FLIGHT

SPILLS PRIOR
TO FLIGHT

INFLIGHT LEAKS

TILE DEBOND
DUE TO IMPROPER
WATERPROOFING

SFOML-WING-8-48

SFOML-WING-8-49

SFOML-WING-8-50

SFOML-WING-9-58

TPS MALFUNCTION
DUE TO BLANKET
FAILURE

SFOML-WING-7-22

BLANKET FAILURE
DUE TO BLANKET
INTEGRITY LOSS

SFOML-WING-8-19

BLANKET FAILURE
DUE TO DEBOND

SFOML-WING-8-21

BLANKET LOSS
DUE TO FLIGHT
OUTSIDE CERTIFIED
ENVIRONMENT (ME)

SFOML-WING-8-44

BLANKET FAILURE
DUE TO LOST
CARRIER PANEL

SFOML-WING-8-20

IMPACT

12

SFOML-WING-9-56

BLANKET
INTEGRITY LOST
DUE TO FAILED
REPAIR

SFOML-WING-9-29

DEBOND DUE TO
BOND INTEGRITY
FAILURE

BOND INTEGRITY
FAILURE

SFOML-WING-9-31

SNEAK FLOW

11

SFOML-WING-9-24

DEBOND DUE TO
IMPROPER
INSTALLATION

SFOML-WING-9-30

BOND INTEGRITY
FAILURE DUE TO
AGE

SFOML-WING-10-15

BOND INTEGRITY
FAILURE DUE TO
OTHER FLUIDS

SFOML-WING-10-16

SFOML-WING-7-22 - TPS MALFUNCTION DUE TO BLANKET FAILURE

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WING/ELEVON STURCTURAL
FAILURE DUE TO WING
OVERLOAD

SFOML-WING-5-1

WING OVERLOAD DUE TO
IMPROPER VEHICLE
CONFIGURATION

SFOML-WING-6-3

WING OVERLOAD
DUE TO INTEGRATED
ENVIRONMENT DIFFERENT
THAN DESIGN

SFOML-WING-6-2

WING OVERLOAD
DUE TO WING/ELEVON
FLUTTER

22

SFOML-WING-6-4

WING OVERLOAD
DUE TO FLIGHT
OUTSIDE ENVELOPE (ME)

43

SFOML-WING-6-1

IMPROPER WING
CONFIGURATION DUE TO
EARLY
GEAR DEPLOYMENT (ME)

SFOML-WING-7-5

ENTRY LOADS
OUTSIDE CERTIFICATION (ME)

SFOML-WING-7-35

INTEGRATED VEHICLE
ASCENT ENVIRONMENT OUT
OF FAMILY (ME)

SFOML-WING-7-36

ON-ORBIT LOADS
OUTSIDE CERTIFICATION (ME)

SFOML-WING-7-37

GROUND PROCESSING
INDUCED LOADS
OUT OF CERTIFICATION
(ME)

SFOML-WING-7-38

FERRY FLIGHT
INDUCED LOADS
OUTSIDE OF
CERTIFICATION

SFOML-WING-7-39

WING OVERLOAD DUE TO WING/ELEVONFLUTTER

SFOML-WING-6-4

WING/ELEVON FLUTTER DUE TO CHANGE IN AIR FLOW

?

SFOML-WING-7-7

WING/ELEVON FLUTTER DUE TO HIGHER SPEED THAN PLANNED

?

SFOML-WING-7-8

WING/ELEVON FLUTTER DUE TO IMPROPER MASS PROPERTIES

SFOML-WING-7-9

WING/ELEVON FLUTTER DUE TO FCS LINKAGE FAILURE

SFOML-WING-7-10

STS-107 ORBITER LOADS

SFOML-WING-8-1

WING/ELEVON FLUTTER DUE TO LOOSE COMPONENT

SFOML-WING-7-11

HEAVY WEIGHT HEAVY ENTRY WT CAUSED SF OF OML- WING/ELEVON (ME)

SFOML-WING-9-1

OTHER

SFOML-WING-9-2

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                                    ┌─────────────────────┐
                                    │    WING/ELEVON      │
                                    │ STRUCTURAL FAILURE  │
                                    │ DUE TO WEAKENED WING│
                                    │     STRUCTURE       │
                                    └─────────────────────┘
                                        SFOML-WING-5-4
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WEAKENED WING STRUCTURE DUE TO STRUCTURE CONFIGURATION NOT PER DESIGN STRENGTH	WEAKENED WING STRUCTURE DUE TO MMOD	WEAKENED WING STRUCTURE DUE TO PLASMA/ELECTRICAL DISCHARGE	WEAKENED WING STRUCTURE DUE TO INTERNAL FIRE (ME)	WEAKENED WING STRUCTURE DUE TO SPACE ENVIRONMENT ("SPACE WEATHER")	WEAKENED WING STRUCTURE DUE TO FATIGUE FAILURE IN WING/ELEVON
25					24
SFOML-WING-6-12	SFOML-WING-6-16	SFOML-WING-6-14	SFOML-WING-6-15	SFOML-WING-6-13	SFOML-WING-6-11

MICRO METEROID	ORBITAL DEBRIS	ON-ORBIT PLASMA/ELECTRICAL DISCHARGE	ENTRY PLASMA/ELECTRICAL DISCHARGE
SFOML-WING-7-31	SFOML-WING-7-32	SFOML-WING-7-40	SFOML-WING-7-41

WEAKENED WING STRUCTURE DUE TO FATIGUE FAILURE IN WING/ELEVON

SFOML-WING-6-11

FATIGUE FAILURE IN WING/ELEVON DUE TO DEGRADED PROPERTIES

SFOML-WING-7-24

FATIGUE FAILURE IN WING/ELEVON DUE TO FRACTURE CRITICAL ITEM

SFOML-WING-7-26

FATIGUE FAILURE DUE TO CORROSION

SFOML-WING-8-25

FATIGUE FAILURE DUE TO FRACTURE TOUGHNESS DEGRADATION

SFOML-WING-8-26

FATIGUE FAILURE IN WING/ELEVON DUE TO SPECTRA EXCEEDED CERTIFICATION PREVIOUS FLIGHT

SFOML-WING-7-25

FAILURE OF <100 FLIGHT LIFE FRACTURE CRITICALITY ITEM

SFOML-WING-8-30

FAILURE OF 100 TO 300 FLIGHT LIFE FRACTURE CRITICAL ITEM

SFOML-WING-8-31

STS-109/107/PAST ORBITER ASCENT SPECTRUM (ME)

SFOML-WING-8-27

STS-109/PAST ORBITER DESCENT SPECTRUM (ME)

SFOML-WING-8-29

STS-109/107/PAST ORBITER ON-ORBITSPECTRUM (ME)

SFOML-WING-8-28

DESCENT SPECTRA EXCEEDED CERTIFICATION PREVIOUS FLIGHT DUE TO CAUSES OTHER THAN WEIGHT

SFOML-WING-9-37

PAST HEAVY WEIGHT

SFOML-WING-9-38

WEAKENED WING STRUCTURE
DUE TO STRUCTURE
CONFIGURATION NOT PER
DESIGN STRENGTH

SFOML-WING-6-12

STRUCTURE CONFIGURATION
NOT PER DESIGN

29

SFOML-WING-7-30

STRUCTURE CONFIGURATION
NOT PER DESIGN
CERTIFICATION DUE TO
UNDETECTED NEGATIVE
MARGINS

28

SFOML-WING-7-29

STRUCTURE CONFIGURATION
NOT PER DESIGN
STRENGTH DUE
TO LOADS

26

SFOML-WING-7-27

STRUCTURAL CONFIGURATION NOT
PER DESIGN STRENGTH DUE TO
DEGRADED STRUCTURAL
PROPERTIES

27

SFOML-WING-7-28

STRUCTURE CONFIGURATION NOT PER DESIGN STRENGTH DUE TO LOADS EXCEEDED PREVIOUS FLIGHTS (ME) CERTIFICATION

SFOML-WING-7-27

INTEGRATED ASCENT LOADS OUTSIDE CERTIFICATION

SFOML-WING-8-33

PREVIOUS STS-109/ORBITER DESCENT LOADS

SFOML-WING-8-32

PREVIOUS STS-109/ORBITER ON ORBIT LOADS

SFOML-WING-8-34

OTHER LOADS EXCEEDING PREVIOUS FLIGHT CERTIFICATION

SFOML-WING-9-39

PREVIOUS FLIGHT HEAVY WEIGHT

SFOML-WING-9-40

STRUCTURAL
CONFIGURATION NOT PER
DESIGN STRENGTH DUE TO
DEGRADED STRUCTURAL
PROPERTIES

SFOML-WING-7-28

DEGRADED STRENGTH
DUE TO CORROSION

DEGRADED STRENGTH
FROM TEMPERATURE
EXPOSURE

DEGRADED STRENGTH
DUE TO CREEP

SFOML-WING-8-35

SFOML-WING-8-36

SFOML-WING-8-37

STRUCTURE CONFIGURATION NOT PER DESIGN CERTIFICATION DUE TO UNDETECTED NEGATIVE MARGIN

SFOML-WING-7-29

ANALYSIS MISSED ON LOW SAFETY MARGIN (M.S. < 0.20) ITEM

ANALYSIS MISSED DEFLECTIONS CRITICAL TO TPS

SFOML-WING-8-38

SFOML-WING-8-39

ANALYSIS MISSED OUT-OF-PLANE DEFLECTION FOR TILE

SNEAK FLOW DUE TO STRUCTURAL DEFLECTION

SFOML-WING-9-26

SFOML-WING-11-13

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                    ┌──────────────────┐
                    │    STRUCTURE     │
                    │  CONFIGURATION   │
                    │  NOT PER DESIGN  │
                    └──────────────────┘
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SFOML-WING-7-30

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┌──────────────────┐        ┌────────────────────────┐
│                  │        │  INCORRECT DISPOSITION  │
│   PROCEDURAL     │        │  OF BUILD MR OR STS-109 │
│     ERRORS       │        │  AND STS-107 FROM PR    │
└──────────────────┘        └────────────────────────┘
         30                            31
  SFOML-WING-8-40              SFOML-WING-8-41
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PROCEDURAL
ERRORS

SFOML-WING-8-40

STS-107 FLOW
OPERATIONS IN
WING

STS-109 OMM
OPERATIONS IN
WING

SFOML-WING-9-41

SFOML-WING-9-42

INCORRECT
DISPOSITION OF BUILD
MR OR STS-109 AND
STS-107 PR

SFOML-WING-8-41

"USE AS IS"
HARDWARE

MODIFIED
HARDWARE

32

SFOML-WING-9-43

33

SFOML-WING-9-44

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                              ┌─────────────┐
                              │  "USE AS IS" │
                              │   HARDWARE   │
                              └─────────────┘
                                    ∩
                              SFOML-WING-9-43
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SPILLS	WING / FUSLAGE ATTACHMENT BOLTS	MID FUSLAGE SIDEWALL OIL CAN	UNSEALED BLIND RIVETS	OTHER	THIN STRUTS	HARD LANDING
○	○	○	○	○	○	○
SFOML-WINGS-10-36	SFOML-WING-10-23	SFOML-WING-10-22	SFOML-WING-10-24	SFOML-WING-10-26	SFOML-WING-10-28	SFOML-WING-10-27

MODIFIED HARDWARE

SFOML-WING-9-44

CLAM - SHELL
REPAIR STRUTS

SFOML-WING-10-30

ELEVON COVE
LEAKAGE BLADE
SEAL REWORK

SFOML-WING-10-29

UNSEATED BLIND
RIVETS

SFOML-WING-10-31

FACILITY, GSE,
SPECIAL TEST EQUIPMENT,
TOOLING, AND
OTHER MODIFIED HARDWARE

SFOML-WING-10-32

STRUCTURAL FAILURE OF ORBITER DUE TO LOSS OF STRUCTURAL MEMBER

SFSM

LOSS OF STRUCTURAL MEMBERS DUE TO FRCS STRUCTURAL FAILURE — SFSM-FRCS

LOSS OF STRUCTURAL MEMBERS DUE TO FWD FUSELAGE FAILURE — SFSM-FWD

LOSS OF STRUCTURAL MEMBERS DUE TO ORBITAL MANEUVERING SYSTEM — SFSM-OMS

LOSS OF STRUCTURAL MEMBERS DUE TO TAIL/RUDDER SPEEDBRAKE FAILURE — SFSM-TAIL

LOSS OF STRUCTURAL MEMBERS DUE TO WINDOW FAILURE — SFSM-WINDOW

LOSS OF STRUCTURAL MEMBERS DUE TO MID-FUSELAGE FAILURE — SFSM-MID

LOSS OF STRUCTURAL MEMBERS DUE TO AFT FUSELAGE FAILURE (ME) — SFSM-AFT

LOSS OF STRUCTURAL MEMBERS DUE TO PAYLOAD BAY DOOR FAILURE — SFSM-BAY

LOSS OF STRUCTURAL MEMBERS DUE TO FAILURE INTERNAL TO PAYLOAD BAY — 35 — SFSM-PAY

LOSS OF STRUCTURAL MEMBERS DUE TO WING FAILURE — SFSM-WING

LOSS OF STRUCTURAL MEMBERS DUE TO CREW CABIN MODULE FAILURE (ME) — SFSM-CABIN

LOSS OF STRUCTURAL MEMBERS DUE TO BODY FLAP FAILURE — SFSM-FLAP

LOSS OF STRUCTURAL
MEMBER DUE TO
FAILURE INTERNAL
TO PAYLOAD BAY

SFSM-PAY

FAILURE INTERNAL
TO PAYLOAD BAY
DUE TO FAILURE
OF CARGO INTEGRATED
HARDWARE (ME)

SFSM-PAY-6-1

FAILURE INTERNAL
TO PAYLOAD BAY
DUE TO PAYLOAD
HARDWARE (ME)

SFSM-PAY-6-2

FAILURE INTERNAL
TO PAYLOAD BAY
DUE TO ORBITER
HARDWARE (ME)

SFSM-PAY-6-3

AERODYNAMIC BREAKUP
DUE TO IMPROPER
ATTITUDE/TRAJECTORY
CONTROL

AC

IMPROPER ATTITUDE/
TRAJECTORY CONTROL
DUE TO CONTROL
EFFECTOR FAILURE

IMPROPER ATTITUDE/
TRAJECTORY CONTROL
DUE TO COMMAND
FAILURE

IMPROPER ATTITUDE/
TRAJECTORY CONTROL
DUE TO INCORRECT
MASS

40

ACEF

37

ACCF

39

ACCG

IMPROPER
ATTITUDE/TRAJECTORY
CONTROL DUE TO
COMMAND FAILURE

ACCF

COMMAND FAILURE DURING
DATA
PROCESSING/TRANSMISSION

COMMAND FAILURE DUE
TO INCORRECT
CALCULATION

ACCF-SIG

38

ACCF-CALC

DATA P/T ERROR
DUE TO EME (ME)

DATA P/T ERROR DUE TO
MDM FAILURE

DATA P/T ERROR DUE
TO GPC FAILURE

DATA P/T ERROR DUE
TO BROKEN WIRE

ACCF-SIG-5-04

ACCF-SIG-5-03

ACCF-SIG-5-01

ACCF-SIG-5-02

EMI CAUSED BY
INTERNAL SOURCE

EMI CAUSED BY
EXTERNAL SOURCE

HARDWARE FAILURE
CAUSES MDM FAILURE

FIRMWARE ERROR
CAUSES MDM FAILURE

HARDWARE FAILURE
CAUSES GPC FAILURE

SOFTWARE ERROR
CAUSES GPC FAILURE

ACCF-SIG-6-01

ACCF-SIG-6-02

ACCF-SIG-6-08

ACCF-SIG-6-09

ACCF-SIG-6-06

ACCF-SIG-6-07

IMPROPER
ATTITUDE/TRAJECTORY
CONTROL DUE TO
INCORRECT MASS

ACCG

INCORRECT
WEIGHT

INCORRECT
CENTER OF
GRAVITY

INCORRECT
MOMENTS OF
INERTIA

ACCG-WT

ACCG-CG

ACCG-INER

ACEF

CONTROL EFFECTOR
FAILURE DUE TO
RCS JET FAILURE

ACEF-RCS

RCS JETS FAIL
TO BURN WHEN
COMMANDED CAUSES
LOSS OF ATTITUDE

RCS JETS BURN
INCORRECTLY WHEN
COMMAND CAUSES
LOSS OF ATTITUDE

ACEF-RCS-5-1

ACEF-RCS-5-2

WING OVERLAOD DUE TO FLIGHT OUTSIDE ENVELOPE (ME)

SFOML-WING-6-1

FLIGHT OUTSIDE ENVELOPE DUE TO FLIGHT CONTROL SURFACE LOAD PATH (ME)

SFOML-WING-7-2

FLIGHT OUTSIDE ENVELOPE DUE TO MISSION DESIGN ERROR (ME)

SFOML-WING-7-1

FLIGHT OUTSIDE ENVELOPE DUE TO OVERWEIGHT/CENTER OF GRAVITY OUT OF LIMITS (ME)

SFOML-WING-7-3